

A NEW TROGLOBITIC QUADRANNULATE LAND-LEECH FROM
PAPUA (HIRUDINOIDEA : HAEMADIPSIDAE s.l.)

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[Accepted for publication 24th October, 1973]

Synopsis

A troglobitic quadrannulate land-leech, *Leiobdella jawarerenis* gen. et sp. nov., is associated with insectivorous bats in the aphotic zone of a cave. Its general somital annulation corresponds with that of *Philaemon*, but differs in having the recurrent limb of the female median region about half the length of the procurrent limb, the lambertian organs posterior, elongate cylindrical, the organ much longer than its duct, and the first pair of nephropores lateral on viii a₁.

A 4-annulate land-leech from the aphotic zone of a cave near Jawarere, Papua, lacks general cutaneous pigment. The retinal cells of the eyes are pigmented; otherwise the preserved animal is opaque white. The animal is the same in life. Although many species of land-leeches are found in the vestibule of many caves, this is the first record of a troglobitic land-leech.

It is also the first record of a troglobitic leech among the euthylaematous leeches, which are characterized by a pharynx whose internal muscular ridges extend along its full length as dorsomedian and ventrolateral ridges, and by the fact both that somite v is the first complete somite and that it forms the lateral and ventral margins of the anterior sucker.

Euthylaematous leeches form a very large and diverse assembly. It contains the majority of leeches with a pharynx and includes not only freshwater, amphibious, terrestrial and terricolous jawed and jawless macrophagous leeches which ingest smaller animals entire, but also freshwater, terrestrial and terricolous jawed sanguivorous leeches.

The only previous record of a troglobitic leech is the aquatic, eyeless, opaque white *Dina absoloni* Johansson, 1913, found in some caves in Europe; but there is now knowledge of a similar leech in a cave in Japan. *D. absoloni* belongs to the smaller compact group having a strepsilaematous pharynx: the internal muscular ridges as a dorsomedian and ventrolaterals anterior to somite vii, transposing posterior to this to be dorsolaterals and a ventromedian for the length of the pharynx; with iv as the first complete somite forming the lateral and ventral margins of the pharynx. All leeches in this group are freshwater and macrophagous.

Considering the great diversity of habit and habitat of the euthylaematous leeches, it is of interest that the first record of a troglobitic species is not that of a macrophagous leech with its capacity to feed on the lesser fauna within a cave but of a terrestrial jawed sanguivore so restricted in habit as to be dependent on a vertebrate.

The 4-annulate land-leeches of the Australian Region are known to me in specimens from Tasmania, southern Victoria, eastern New South Wales, eastern Queensland, the Northern Territory, Papua and Lord Howe Island. They are a complex group which I have not yet been able to bring into satisfactory zoological order as a whole. Some few are distinctive in external meristic morphology, in the form of the auricle and in pattern.

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The majority are monotonous in external meristic morphology, in the morphology of the alimentary tract and in the morphology of the reproductive systems, but they separate by pattern into groups, in the same manner as our aquatic jawed sanguivores. When the latter are grouped by pattern, genera can be separated within each group by distinctive differences in the morphology of the median regions of the reproductive systems. This is not possible in the 4-annulates since the median regions have been monotonous in form in those previously studied. This seemed to leave only pattern as a primary guide to genera.

In the absence of pattern, I was initially reluctant to base a new genus on the Jawarere leech. It seemed preferable to describe it as a new species and to assign the species to the genus *Philaemon*, based on *P. pungens* of Victoria (the traditional genus to which 4-annulate leeches are assigned), leaving the nature of the new genus until such time as a patterned species could be described as the type species. However, I now realize that both the form of the female median region in the Jawarere leech and the form of the lambertian organs are different from those of all other 4-annulates known to me. The combination of these with other features described below fully warrants the provision of a new genus.

A particular feature is the location of the first pair of nephropores in the marginal field, lateral on viii a₁ in the Jawarere leech (and also in a second species of 4-annulate from Papua still to be detailed and named).

Earlier (1969) I drew attention to fig. 8 in Blanchard (1917) which shows in a diagrammatic manner the dorsal aspect of the anterior somites of *Philaemon minutus* Blanchard 1917 of Samoa. In this figure, a pair of nephropores, labelled the second pair, is shown on viii a₁. I suggested there had been a simple error, or alternatively that these were in fact the first pair of nephropores. The latter now seems to be the case.

Lambert (1898) fully establishes the first pair of nephropores as labial in position in *P. pungens*, i.e. sited on the margin of the sucker at the level of vi a₁ (posterior to the position in my experience). They are labial and at iii/iv in *P. grandis* Ingram 1957 of Tasmania, and at about this level in other Australian 4-annulates I have studied, including *Neoterrabdella australis* Richardson, 1969. The first pair of nephropores is not recorded as other than labial in two-jawed and three-jawed 4-, 5- and 6-annulates elsewhere, and known to me only as labial in the 4-, 5- and 6-annulates in eastern Australia which are all two-jawed, with one exception.

The exception was the two-jawed 5-annulate *Idiobdella seychellensis* Harding, 1913, in the Seychelle Islands, a leech with other morphological characteristics which cause this genus to be separated from terrestrial jawed sanguivores elsewhere.

To date I have dissected specimens of 10 or 11 species of land-leeches in the Australian Region. I have published (1969) an account of *Neoterrabdella australis*, and there is more recently (Richardson, 1974) an account of *Domaniabdella tristriata* (Goddard, 1909). To this knowledge can be added Lambert's description (1898) of *Philaemon pungens* and Ingram's descriptions (1957) of *P. pungens* and *P. grandis*. This is not a full fauna, but it is a usable sampling.

In all these, the ovaries are posterior in xii, or in the contiguous annuli of xii and xiii; the oviducts join at xii/xiii or anterior in xiii; the initial recurrent limb of the female median region is essentially equal in length to the length of the terminal procurvent limb, the latter slightly longer, about the length of an annulus or a little longer in those in which the female pore is median or slightly anterior in xii.

In the Jawarere leech, the ovaries and the junction of the oviducts are essentially at the same levels as in the others, but the initial recurrent limb of

the median region is short, about half or slightly less than half of the length of the terminal procurrent limb. The difference is the same in a contracted as in an extended specimen.

Of the 4- and 5-annulate Australian land-leeches which I have dissected, only *Neoterrabdella australis* lacks lambertian organs.

In all the 5-annulates known to me, including *Chthonobdella limbata* Grube, 1866 (described by Lambert in 1899 under the name of "*Geobdella australiensis*") of central eastern New South Wales, "*Geobdella*" *whitmani* Lambert, 1899, of southern eastern Queensland, and *Domanibdella tristriata* of Papua, the lambertian organs are either posterior in position, situated in the contiguous halves of xxii and xxiii, the organ ovoid about the length of a somite, and the duct and organ nearly equal in length; or, as in *D. tristriata*, the organ longer, elongate cylindrical, from xxi/xxii to the middle of xxiii, the duct very short, its length no more than the width of the organ.

In the 4-annulates, the lambertian organs are anterior; in xx, the organ obtusely ovoid, short, and the duct long; or in the contiguous parts of xx and xxi, the organ longer, the duct shortened; but in both cases, the organ is much shorter than the duct, the length of the organ half or less than half of the length of the duct. The organs are in xx in *Philaemon pungens* (Lambert, 1899, pl. x, fig. 2).

In the Jawarere leech, the lambertian organs in xxi and xxii are elongate cylindrical, folded, the length of two somites, and the organ much longer than the duct, about twice its length, i.e. the lambertian organs and ducts differ from the form in the 4-annulates and resemble the form of these structures in the 5-annulates.

Only the general external meristic morphology is known for the great majority of land-leeches.

Phytobdella catenifera Moore, 1938, is a two-jawed 6-annulate land-leech from Johore, India. In his description of this species, Moore shows (1938, pl. v, figs 10, 11) the initial recurrent limb of the female median region as short, about half the length of the terminal procurrent limb, and the lambertian organ as posterior in position, elongate, and more than twice the length of the short lambertian duct. Both therefore are the same as the Jawarere leech.

Keegan *et al.* (1969, fig. 39A) show the female median region in a two-jawed 6-annulate from Laos as having the two limbs equal in length.

Moore (1944) describes the lambertian organs as posterior, extending from xxi to the level of the end of the postcaecum, the duct short, the gland seven to nine times the length of the duct, in *Phytobdella lineata* Moore, 1944, and *Phytobdella maculosa* Moore, 1944, both of Papua. He does not adequately describe the female reproductive system. These are both two-jawed 6-annulates.

A two-jawed 6-annulate collected by Dr. Ewers at Mount Suckling, differs from the above species in details of the somital annulation. I find in this specimen that the two limbs of the female median region are essentially equal in length and that the lambertian organ is elongate cylindrical, folded on itself, extending anteriorly to xxi, the duct short, the gland six to seven times the length of the duct. Mount Suckling lies in Papua.

I review briefly elsewhere (Richardson, 1974) the manner in which land-leeches have been separated systematically. Initially, all 4-annulates were placed in the genus *Philaemon*, with the species separated on the location of the genital pores and the annulation of vii. Later, genera were separated on the number of jaws and on the presence or absence of lambertian organs.

To this I added (1969) the annulation of xxiv and xxv, the form of the auricle, and, recently, the annulation of vi, vii, etc., making a further step in the separation of genera.

The 4-annulate genera previously recognized in the Haemadipsidae (Soos, 1967) were *Philaemon*, a name proposed by Blanchard in 1897 for 4-annulates, but without detail until Lambert (1898); *Tritetrabdella* Moore, 1938; *Nesophilaemon* Nybelin, 1943. To these I added *Neoterrabdella* Richardson, 1969, and, from the nature of the reproductive systems, I removed *Nesophilaemon* from the Haemadipsidae.

Tritetrabdella of Penang, Malaya, has three jaws, lacks lambertian organs; xxiv, 2-annulate; genital pores, xi a_2/b_5 and xii $a_2 (a_2/b_5)$.

Neoterrabdella of the Northern Territory, Australia, lacks lambertian organs; xxiv, 3-annulate; xxv, 2-annulate; the auricles large, formed by the lateral ends of xxiv-xxvii; genital pores, xi $a_2 (a_2/b_5, b_5)$ and xii b_6 . *Philaemon*, of Victoria and Tasmania, Australia, as in Lambert (1898) and Ingram (1957), has lambertian organs; xxiv, uniannulate; auricles formed by the lateral ends of xxv-xxvii; genital pores, xi $b_5 (? b_5/b_6)$ and xii $b_6 (? b_5/b_6)$. Both genera have two jaws.

With genera separated as above, the Jawarere leech would be assigned to *Philaemon* as a species distinct in having the genital pores in xi b_6 and xii a_2/b_5 .

To the previous criteria for the separation of genera we can add the form both of the lambertian organ and of the female median region, and also the location of the first pair of nephropores. This combination excludes the Jawarere leech from the previously established genera.

If this is adopted, some generic separations can be anticipated in the 6-annulates, all currently in the genus *Phytobdella*.

Genus LEIOBDELLA gen. nov.

Derivation. *Leio*, smooth + *bdella*, leech.

Description. Somites viii-xxii, complete 4-annulate (total, 15); xxiii, incomplete 4-annulate; xxiv-xxvii, incomplete uniannulate; six annuli posterior to xxiii a_2 ; auricles lateral to xxv, xxvi, xxvii, margin lobate, incised; first nephropores lateral on viii a_1 ; duognathous; jaws housed in an annular groove; teeth, minute; salivary glands, sparse, no obvious columns of aggregated ducts; extrinsic radial musculature in vii-ix; pharynx thin-walled, internal muscular ridges represented by an undivided dorsomedian and a pair of ventrolateral ridges; pharynx terminates at viii/ix; crop compartmented, caecate, the compartments each with a pair of primary caeca at the median level and reduced secondary anterior and posterior caeca, excepting xix with secondary anterior caeca and postcaeca originating at the median level, extending in the paramedian chamber to xxiii/xiv and each continuing as a lambertian duct shorter than the elongate cylindrical lambertian organs in xxi and xxii; genital pores, xi $(b_5/b_6) b_6$ and xii a_2/b_5 ; male median region, amyomeric, micromorphic; female median region, myomeric, mesomorphic, haemadipsoid; testes, saccular; anterior region of the male paired duct reflecting in the median splanchnic chamber at xi/xii or in xii as a primary posteriorly directed loop, an epididymis on the initial portion of the recurrent limb, a sperm duct completing the recurrent limb and extending along the length of the procurrent limb; ejaculatory bulbs, present; ejaculatory ducts enter the anterior aspect of the basal portion of the minute atrium; ovaries, saccular, at xii/xiii or in xiii; oviducts join at xii/xiii to median in xiii; female median region, a posteriorly directed loop reflecting in xiii-xiii/xiv, the initial recurrent limb short, half or less of the length of the terminal procurrent limb; oviducal glandular sac expanded on the posterior aspect of the elbow of the loop.

Terrestrial. Sanguivorous. Australian Region, Papua.

Pattern. ? The type species, cavernicolous and lacking pattern.

Type species. *Leiobdella jawarerensis* sp. nov.

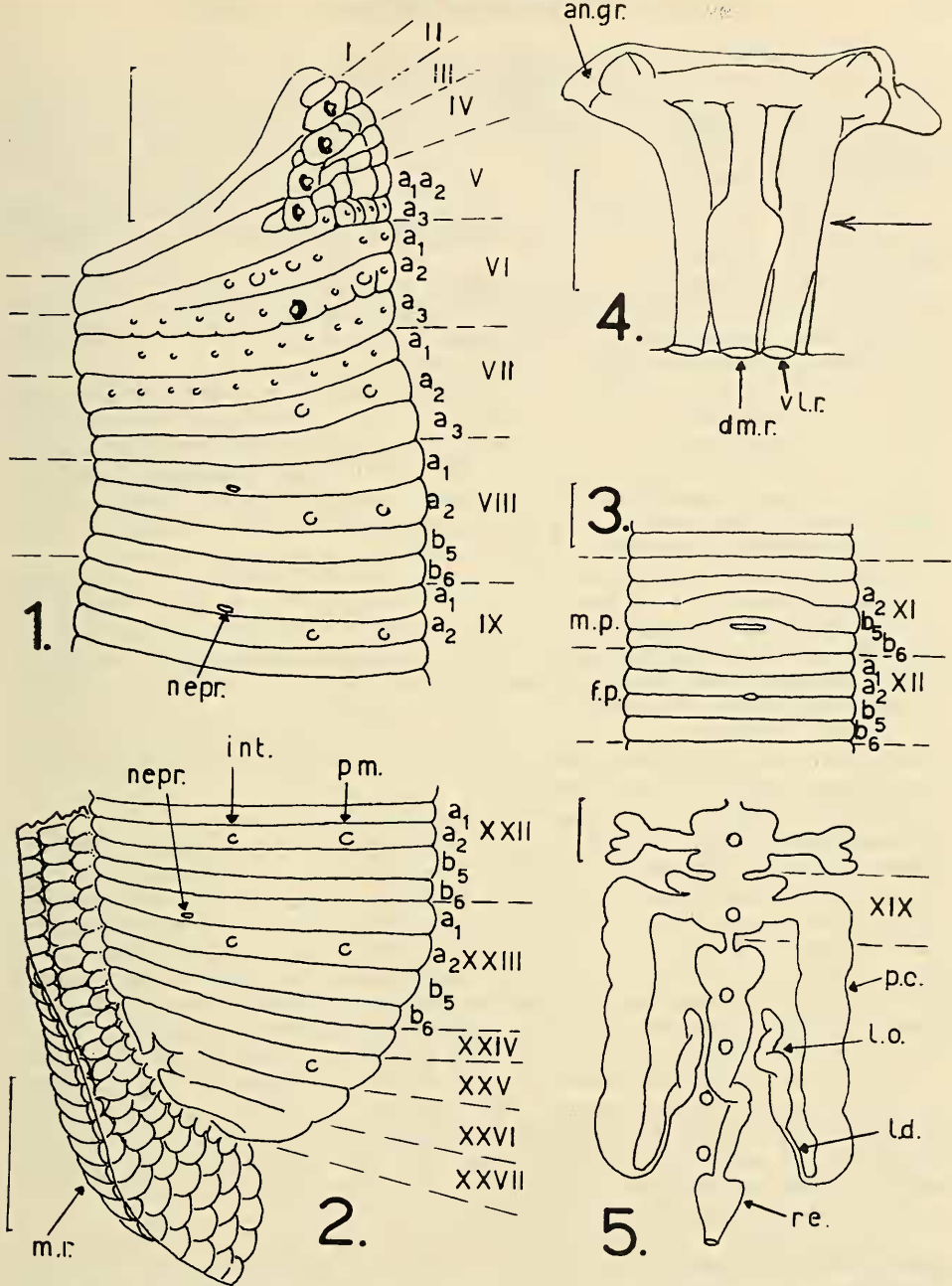


Fig. 1. *Leiodella jawarereensis* gen. et sp. nov. 1. Annulation of somites i-ix, left lateral view, sensillae indicated in v-vii. 2. Annulation of somites xx-xxvii; the auricle; posterior sucker; left lateral view. 3. Ventral view of somites xi and xii, showing the location of the genital pores. 4. Annular groove, jaws, entrance to pharynx, and the internal muscular ridges, as exposed by a median ventral incision; arrow marks midpoint in length of pharynx. 5. Caecation of crop, somites xviii and xix, postcaeca, lambertian organs, intestine and rectum.

1.1-1.5 drawn from the type.

Somites and somital ganglia indicated by roman numerals; somital limits, broken lines; annuli, "a₂", etc. Scales equal 1.0 mm.

Abbreviations: an.gr., annular groove; dm.r., dorsomedian muscular ridge; f.p., female pore; int., intermediate somital sense organs; l.d., lambertian duct; l.o., lambertian organ; m.p., male pore; nepr., nephropore; p.c., postcaecum; pm., paramedian somital sense organ; re., rectum; vl.r., ventrolateral muscular ridge.

Leiobdella jawarereensis sp. nov.

(Figs 1, 2, 3)

Type. One specimen, 19.5 mm long. Jawarere Cave, Papua. 14/7/68. Collector W. H. Ewers. Deposited Australian Museum, Sydney, Collection No. W. 4299. Dissected.

Paratypes. Two specimens, 18.0 and 42.0 mm long. Same locality, date and collector as type. Deposited Australian Museum, Sydney, Collection No. W. 4303. Dissected.

Representative material from the same collection has been placed in the Papua and New Guinea Museum and Art Gallery, Port Moresby.

Excepting the reproductive systems, which are detailed from the paratypes, the following account is based on the type.

General form. In a preserved state, moderately contracted; the body generally low convex across the dorsum, the margins obtusely rounded, the venter flat; widest along the posterior half of the body, reducing gradually in width anteriorly to form a narrow short region, a base for the wider anterior sucker which is about two-thirds of the maximum width of the body; posteriorly, narrowing abruptly along the postnephric somites to form the base for the posterior sucker, which is slightly wider than the body. Richly papillate.

Total length, 19.5 mm; the anterior sucker, 3.6 mm wide at v/vi; the body, 2.8 mm wide and 2.0 mm deep at viii/ix, 3.0 mm from the tip of the velum, 5.2 mm wide and 3.5 mm deep at 10.0 mm from the tip of the velum, 6.0 mm wide and 4.0 mm deep at 14.0 mm, and of these dimensions to xxii a₂; narrowing then to the base of the sucker, 2.0 mm wide at xxvii, 18.0 mm from the velum; the posterior sucker, 5.8 mm wide and 6.0 mm long.

Colour. Preserved in alcohol. Immaculate, opaque china-white on all aspects without dark pigment other than in the retinal cells of the eyes and a few spaced small erratic patches lateral to the ocular arch.

Pattern. There is no indication of any pattern.

Annulation (Figs 1.1, 1.2, 1.3). Interannular and intersomital furrows equivalent and somital limits not directly recognizable.

Richly ornamented with low obtusely-rounded papillae, most being marked with a white sensory patch. Papillae arranged as a transverse row on each annulus, large and small on the dorsal and lateral aspects, only small on the venter; the large papillae appearing as though arranged in sinuous longitudinal lines which are not recognizably related to the lines and fields of the somital sense organs. In somite xvi, each annulus carries about 25 to 27 papillae.

The somital sense organs of the dorsal and lateral aspects are most difficult to recognize as longitudinal series, and cannot be recognized with any confidence on the venter. Confusion comes from the fact that b₅ is by far the longest annulus in most somites, and it is only with the identification of a₁ by the presence of the minute and obscure nephropores that the somital annulation can be analysed. The nephropores are central in a₁ in anterior somites and close to the posterior edge of the annulus in posterior somites.

There is a soft narrow rounded rim on an undivided thin semitransparent membrane which forms the lateral and ventrolateral wall of the chamber lateral to somites i-iv and anterior to v, which in turn forms the ventral portion of the margin of the sucker, and which, with vi, completes the wall of the chamber of the sucker. There is a transverse row of some eight large white sense organs on the dorsal portion of the rim of the sucker.

A weak but distinct short furrow extending across the median field separates somite i from ii; ii, uniannulate, the first pair of eyes, as also the eyes in iii and iv, located each in a large areola, and some areolation also in i, ii, iii, with indications of areolation in iv and v in the median and paramedian fields; iii, uniannulate, with the second of eyes; iv, 2-annulate between the ocular areolae, the third pair of eyes in a₁a₂=a₃; v, incomplete 2-annulate, the fourth pair

of eyes in $a_1 a_2 > a_3$, the furrow $a_1 a_2 / a_3$ terminating at the ocular areolae, v uni-annulate below this and forming only the ventral margin of the sucker; vi, incomplete 3-annulate, $a_1 = a_2$ slightly $> a_3$; the fifth eyes in a_2 , the furrow a_1 / a_2 extending into the marginal area, and vi 2-annulate across the venter; vii, 3-annulate, $a_1 = a_2$ slightly $> a_3$.

Somites viii-xxii complete 4-annulate (total, 15); the midnephric series with $a_1 < a_2 = b_5 > b_6$ or $a_1 < a_2 < b_5 > b_6$.

The first nephropores lateral on viii a_1 .

Somite viii, $a_1 = a_2$ slightly $< b_5 > b_6$; ix, $a_1 < a_2 < b_5 > b_6$; x, not assessable; xi, $a_1 < a_2 = b_5 > b_6$, as also xii; xiii, $a_1 < a_2 = b_5 ? b_6$; xiv, $a_1 < a_2$ slightly $< b_5 > b_6$, as also xv; xvi to xxii, with $a_1 < \text{or slightly } < a_2 < b_5 > b_6$ (and $b_6 >$ than the following a_1); xxiii, incomplete 4-annulate, a_1 slightly $< a_2 > b_5$ slightly $> b_6$, the last pair of lateral nephropores close to the posterior edge of a_1 , and xxiii a_2 the last annulus fully formed across the venter, b_5 and possibly b_6 cross the venter as very thin ridges.

Somites xxiv, xxv, xxvi, xxvii, incomplete uniannulate. Anus at the posterior border of xxvii.

Auricles, relatively small, restricted to the lateral ends of xxv, xxvi, xxvii; xxv expanding into a poorly-formed anterior pointed lobe; xxvi, shorter, pointed, and bridging between the anterior lobe and the larger rounded posterior lobe which is formed by xxvii. The auricles roof over a small but distinct cavern.

The dorsum of the posterior sucker carries some six concentric rows of papillae. The ventral surface has a small central papillate disc, about one-quarter of the diameter of the sucker, and radiating from the disc are muscular ridges which subdivide to end as about 100 ridges on the margin of the sucker. The clamp, small, acutely triangular.

Genital pores, male anterior in xi b_6 ; female, xii a_2 / b_5 .

Alimentary tract (Figs 1.4, 1.5). Central in the disc of the anterior sucker is a small transversely oval aperture, 1.0 mm wide. This is at the level of vi/vii, immediately anterior to the ventral portion of the anterior ganglionic mass which is compact, almost globular, and separated from the first independent ganglion (vii) of the nerve cord by a space approximately equal to the length of the ganglion.

The rim of the oval aperture is rounded, and the rim continuous with a thin membrane.

A median ventral longitudinal incision shows a very well-developed deep wide annular groove internal to the aperture, the anterior wall of the groove being formed by the thin membrane and the posterior wall by the entrance to the pharynx and the jaws.

There is no jaw or muscular pad in the dorsomedian position. The dorso-medial and dorsolateral portions of the entrance to the pharynx have the appearance of a narrow transverse flat uniformly muscular band, continued posteriorly as an initially narrow dorsomedian primary internal muscular ridge, wider in the posterior half of the pharynx and without indications of secondary subdivision.

The two ventrolateral jaws are narrowly separated ventrally, housed in the annular groove without any indication of crypts or pockets; each jaw, minute, the height of the medial aspect about 0.2 mm, the width of the base about 0.3 mm, and this aspect obtusely rounded in profile; the dental margin about 0.3 mm long, armed with a single row of minute sturdy teeth which appear to be spaced, taller at the median end, and the height diminishing along the row. (Because of the small size of the jaw, this could not be removed for a count of the teeth. No teeth were seen on jaws dissected from other specimens.)

Each jaw continues posteriorly as a primary internal muscular ridge, initially wide, then narrowing in the posterior half of the pharynx.

There are no dorsolateral or ventromedian internal muscular ridges.

The entrance to the pharynx appears wide in the absence of a dorsomedian jaw. The lumen is tubular, tapering.

Salivary glands are sparse, located in vii-ix, without any indication of dorsal columns of aggregated ducts.

The pharynx terminates at viii/ix followed by the compartmented crop; the compartment in ix, simple; in x, xi, each with a small caecum at the median level on each side; xii, ?; xiii and posteriorly including the postcaeca, containing coagulated blood, the casts indicating a pair of primary caeca at the median level extending into and lobed in the paramedian chambers, an anterior pair of small simple caeca retained in the median splanchnic chamber, and also possibly a posterior pair of small simple caeca.

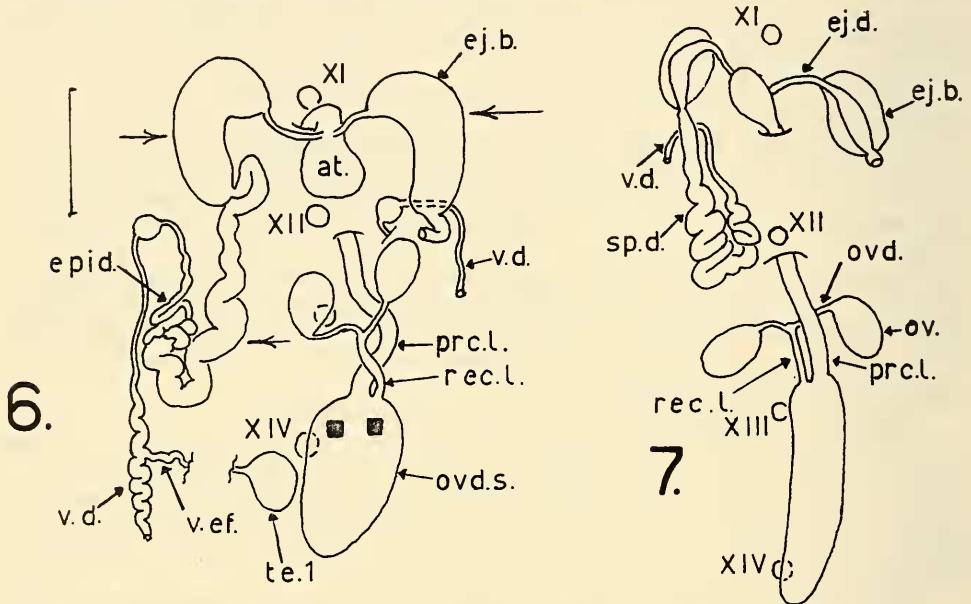


Fig. 2. *Leiobdella jawarereensis*. Anterior region of male paired duct; male median region and female reproductive system of paratypes. 6. Strongly contracted 18.0 mm specimen, male atrium turned posteriorly to show the termination of the ejaculatory ducts; arrows indicate dorsal aspect of sperm duct and ejaculatory bulb, and black squares indicate the original position in the median chamber of the posterior end of the primary loop on the anterior regions of the male paired ducts. 7. Fully extended 42.0 mm specimen.

Abbreviations: at., atrium; ej.b., ejaculatory bulb; ej.d., ejaculatory duct; epid., epididymis; ov., ovary; ovd., oviduct; ovd.s., oviducal glandular sac; prc.l., procurent limb, female primary loop; rec.l., recurrent limb, female primary loop; sp.d., sperm duct; te., testis; v.d., vas deferens; v.ef., vas efferens.

The compartment in xix with postcaeca originating at the median level and extending into the paramedian chambers, each postcaecum reducing in the posterior half of xxiii to form a narrow duct which passes through the paramedian palisade of dorsoventral muscles into the median splanchnic chamber, then anteriorly to the level of xxii/xxiii, where it expands into the elongate cylindrical lambertian organ which terminates bluntly at about xx/xxi. The lambertian organs are parallel, ventral to the intestine.

The lambertian duct is relatively short; the lambertian organ is about twice the length of the duct.

The compartment in xix reduces to be narrowly tubular, connecting terminally at xix/xx to the much wider intestine which commences with a bilobed

chamber in xx, continues posteriorly as a tapering tube connecting at xxiii/xxiv to the short tapering rectum.

Reproductive systems (Figs 2.6, 2.7). Detailed and figured from the paratypes.

Haemadipsoid: the anterior region of the paired male ducts reflected in the median splanchnic chamber on a posteriorly directed loop; ejaculatory bulbs, present; male median region, a weakly muscular atrium; female median region formed on a posteriorly directed loop with a glandular asymmetrical oviducal sac.

Genital pores, xi $b_5/b_6(b_6)$, and xii a_2/b_5 .

The type, male, mature, the organs strongly compacted, and in general unsuitable for detailed description. Dissected sufficiently to establish that the morphology and relationships of the reproductive systems agree with the following description based on the dissection of an 18.0 mm contracted specimen and a 42.0 mm extended specimen.

Two facts should be noted. Both the anterior region of the male paired ducts and the median regions are located in the median splanchnic chamber ventral to the crop; the anterior region of the male paired duct and the female median region are anchored anatomically only at the anterior ends and are subject to displacement posteriorly on contraction.

The distinct paired small sacs on the vas deferens in xii in the 18.0 mm contracted specimen are new to me. They are not present either in the type or in the 42.0 mm extended specimen. They are located on the duct in the paramedian splanchnic chamber at the point where the duct passes through the paramedian palisade of dorsoventral muscles. They might possibly be a temporary artefact, a consequence from a strangulation of the duct in contraction.

Testes sacular, 10 pairs in the median chamber, the most anterior pair in xiv; each testis connecting laterally by a short vas efferens to the tortuous white vas deferens in the paramedian chamber; the vas deferens, reducing in diameter in xiii, continuing as a very narrow (diameter less than 0.1 mm) thin-walled semitransparent straight duct which passes through the paramedian palisade in xii and extends in the median chamber as a posteriorly directed loop reflecting at xii/xiii or in xiii.

The initial half of the recurrent limb of the loop is a thin-walled narrow duct, slightly tortuous as though a poorly defined epididymis, continuous with the tortuous much-folded wider thin-walled sperm duct which completes the initial limb, increasing in diameter as it passes around the elbow of the loop and becomes loosely folded along the greater length of the procurrent terminal limb to about xi/xii, where it narrows abruptly before joining the ejaculatory bulb.

The right and left loops of the male paired ducts are parallel, not tandem, in arrangement, and the posterior portion of each loop forms a large globular mass dorsal to the female system.

The ejaculatory bulbs are stoutly fusiform, muscular, opalescent, terminating obtusely; the duct continues as a narrow opalescent ejaculatory duct which connects to the anterior aspect of the basal portion of the male atrium. The right and left ducts enter independently.

The male atrium is small, extending above the ventral nerve cord, and the wall is thinly muscular.

The female reproductive system is contained wholly within the median splanchnic chamber.

The ovaries are pyriform, situated in the contiguous annuli of xii and xiii, each connected by a short oviduct to the recurrent limb of the median region which is formed on a posteriorly directed primary loop reflecting in the posterior annuli of xiii or at xiii/xiv.

The recurrent limb is thin-walled, narrower than the strongly muscular procurent limb which terminates at the genital pore and is twice or more the length of the recurrent limb.

The oviducal glandular sac expands from the posterior aspect of the elbow of the primary loop and terminates obtusely in xiv.

No distinct, i.e. compact, albumin or prostate glands were recognizable.

Additional material. Australian Museum, Sydney. Collection No. W. 5421. Musgrave River area, Central District, Papua. Inside cave. 28.ii.1960. Collector J. Barnaby. Ex Collection No. c/6, Department of Agriculture, Port Moresby. One specimen, 32.0 mm long. *Leiobdella jawarerenensis*. Determined L. R. Richardson, 1973.

Discussion. *Leiobdella jawarerenensis* is one of the large 4-annulate leeches. Fully extended specimens measure up to 55.0 mm. It is variable in appearance. Strongly to moderately extended specimens are distinctly papillate, each papilla tipped with a white sense organ. Fully extended specimens are smooth; somital sense organs and sensillae showing as small white patches, of much the same size; interannular furrows, weak and difficult to identify; some but not all of the testes showing through the ventral body wall.

Cavernicola have been the basis for much speculation on adaptation and isolation as factors inducing directive or non-directive evolution.

The troglobites, animals committed to persistent darkness, constant temperature and humidity, and a diet restricted because it is not mediated by photosynthetic plants, include animals from many phyla. Among these, the common reduction of visual organs, the loss of cutaneous pigment and other associated changes are taken as major evidence of convergent regressive evolution.

As a sanguivorous land-leech, *L. jawarerenensis* is an interesting addition to this area of speculation. It inhabits the aphotic zone. This fact and the fact of the absence of general cutaneous pigment, qualify it for classification as a troglobite. I am unable to point to any other feature which supports this classification.

The eyes are not obviously reduced and the retinal cells are pigmented, both as in some other troglobites. In the study of the land-leech in the bush I reached the conclusion (1968) that vision has no part in bringing the leech to the host. *L. jawarerenensis* provides further evidence in support of this conclusion.

Dr. Ewers informs me that the portion of the cave inhabited by this leech is tunnel-like, reducing to a height of four feet at one place where there are some six leeches to the square foot. Swiftlets, fructivorous bats and insectivorous bats enter the cave. No vertebrate other than the insectivorous bat enters the region occupied by the leech. The leech pays no attention to human beings.

Photographs sent to me by Dr. Ewers show leeches taking a blood meal from bats. In these photographs the posterior sucker of the leech is attached to the wall of the cave; the body, extended; the anterior sucker attached to the arm, or anterior aspect of the fore-arm, or to the base of the web of the hand.

In reply to my enquiry, Dr. Ewers informs me that they have never seen a leech entirely attached on a bat. When the bat flies, the leech remains on the wall of the cave.

L. jawarerenensis is accordingly a troglobite obtaining its nutriment from a host which finds its food beyond the limits of the cave. Blood is a well-balanced tissue, its composition held within the close limits necessary for the well-being of the animal. Other than a monotony of diet, in the sense that *L. jawarerenensis* feeds from only one host species, the nutrition does not differ from that of the land-leech in the bush.

I have shown (1968) that the land-leech in the bush has a closely defined habitat preference. Activity is dependent on soil moisture and humidity, the leech becoming inactive when these are low and anhydrobiotic in drought.

In many collections from the field, the majority of the crops are empty. When engorged land-leeches are held in captivity, the crop contains blood for six to nine months after the meal. The indications are that blood meals are few and widely-spaced for the land-leech in the bush, a circumstance arising both from the task of finding a host and from its varying periods of inactivity.

Dr. Ewers informs me that most of the Jawarere leeches contain blood. This is the case for the specimens he has sent to me. From this it seems that the stable environment of the cave permits long periods of activity, even possibly continuous activity with a host which is readily available.

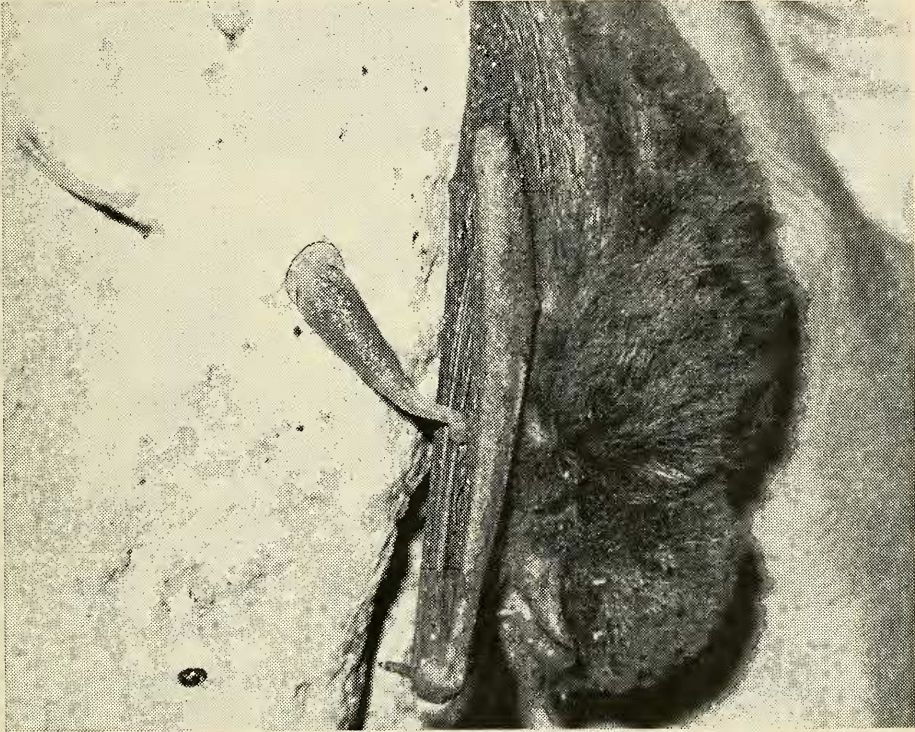


Fig. 3. *Leiobdella jawarereensis* feeding from an insectivorous bat in the Jawarere Cave. Photo: A. Johnstone.

The presence of this land-leech in the aphotic zone raises the usual queries as to the manner in which the troglobite becomes committed to this zone. In this case, the survival of the leech is wholly dependent on the presence of the insectivorous bat.

I have provided (1968) the basis for showing both that the land-leech is a poor traveller, and that a land-leech population is restricted to the limited area of a suitable habitat. From this it becomes difficult to regard the land-leech as an animal capable of active dispersal. This would require travel through environments unsuitable for activity on the part of the leech.

Land-leeches are known in the vestibule of caves. In the case of *L. jawarereensis*, the invasion of the aphotic zone can be assessed as having high probability since the uniformity of the cave environment does not provide

barriers to the active dispersal of the leech. It required only that the leech come into an area occupied by a suitable host animal for a community to be established.

The alternative is that the leech was brought to this part of the cave by passive transport on the host animal. The probability for this can be assessed as very low, unless the bat behaves in a manner differing from other insectivorous bats, e.g. crawls over the ground or climbs through low vegetation in leech-infested areas in addition to feeding on the wing. If there is such behaviour, the probability continues to be low because of the manner in which the fed leech readily departs from the host.

In either case, it seems that the population of *L. jawarerenis* in this cave is isolated.

The land-leech is a convenient laboratory animal. *L. jawarerenis* is a troglobite suitable for experimental studies. It would be valuable to use leeches from this cave to study the consequences both of a varied diet and of exposure to light, in order to see if these lead to the establishment of general cutaneous pigmentation.

ACKNOWLEDGEMENTS

I am grateful to the Australian Research Grants Committee, whose award for studies of the zoology of the Australian freshwater and terrestrial leeches assisted this research.

I thank Dr. W. H. Ewers, University of Papua and New Guinea, for the specimens on which this account is based and for information on *Leiobdella jawarerenis*. I also thank Mr. A. Johnstone, Biology Department of the same University, for the photographs of the leech and the bat taken in the cave.

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